17e Journées Scientifiques
GFP-Section Est / FRMNGE
06 et 07 juillet 2021

Manufacturing of bio-based composite filaments by extrusion/coating and their properties for additive manufacturing

Xikun Wu[1], Geoffrey Ginoux[1], Samir Allaoui[1]

[1]Institut de Thermique, Mécanique, Matériaux - 9A Rue Claude Chrétien, 08000 Charleville-Mézières
Email: xikun.wu@etud.univ-pau.fr

Abstract

Nowadays, with the industrial development and the boost of industrial synthesis, current ecological issues come up as environmental pollution and resource shortage. Therefore, in the domain of composite materials processing, it is getting more and more favorable to use bio-based composites in place of petroleum-based ones. On the other hand, additive manufacturing (AM) has grown as a significant trend thanks to its advantages as flexible design, rapid prototyping and waste minimization over conventional methods. More recently, continuous fiber reinforced composites manufactured by AM are getting attention as solutions for lightweight and multifunctional parts [1], but the technology needs to be developed regarding the available materials.

Combining these two current aspects of consideration mentioned above, we decided to develop new formulations of materials to additively manufacture specimens by using bio-based and functionalized composite filaments, which are manufactured by our extrusion/coating system, then compare their mechanical properties with those done by non-bio-based composites. The continuous fibers that are used in this process are natural fibers as flax and cotton/hemps fibers, and metallic filaments as copper-based filaments for electronic applications. The polymer matrices used are PLA and PA11 as bio-based matrices, and PP and PA66 as petroleum-based matrices. The whole processing flow chart is exhibited in Fig. 1.

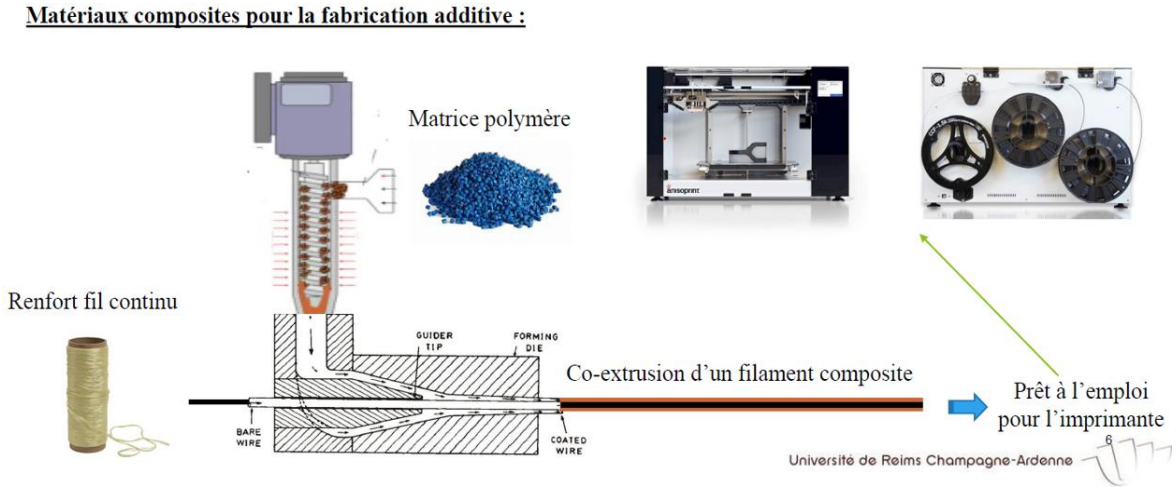

Fig 1. Flow chart of the whole manufacturing process (from extrusion/coating to additive manufacturing)

Viability of the developed filaments is characterized by: FTIR for verifying the removal of interfacial interrupting substances in natural fibers, DSC/TGA for obtaining the thermal properties of the polymers and the fibers, capillary rheometer for obtaining the rheological behaviors during the processing of the composites [2], tensile test for comparing the different mechanical properties between bio-based composites and synthetic ones, and tomography for studying the morphology of the materials and fibers, the dimensional accuracy, and the fracture phenomena.

These findings will have significant implications on the suitability of bio-based composites for additive manufacturing as potential candidate for replacing synthetic materials and for adding multifunctionality to additively manufactured parts.

Reference

[1] Samir Kasmi, Geoffrey Ginoux, Samir Allaoui, Sébastien Alix, Investigation of 3D printing strategy on the mechanical performance of coextruded continuous carbon fiber reinforced PETG. *Journal of Applied Polymer Science*, 50955 (2021).
[2] Geoffrey Ginoux, Philippe Dony, Isabelle Vroman, Sébastien Alix, Decrease in non-linear viscosity of a polylactide nanocomposite with regard to the clay volume fraction. *Rheologica Acta* **59,** 269–278 (2020).